Ministerie van Verkeer en Waterstaat

Rijkswaterstaat

# Flood protection in the Netherlands

## A risk based decision framework for flood protection

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# Introduction

1. Introduce colleagues from the Dutch side. All earlier involved in cooperation between the USACE and our organization Rijkswaterstaat.
2. Today's presentation is following other recent activities in this cooperation such as:
   - Visit to New Orleans district (Jorissen Timmer), October last year
   - Participation design workshops
   - Review of the preliminary Technical Report from LACPR.
   - Recent workshop in the Hague (July this year) on several topics a.o. Risk based design workshop.
3. Question Edmond Russo to develop a joint risk based design framework for the Louisiana situation.

# Outline

1. Dutch approach to safety and developments in the approach.
2. Theoretical framework for risk based decisions.
3. Some general lessons and characteristics of the Dutch approach.
4. The first ideas in applying this framework to the Louisiana situation.

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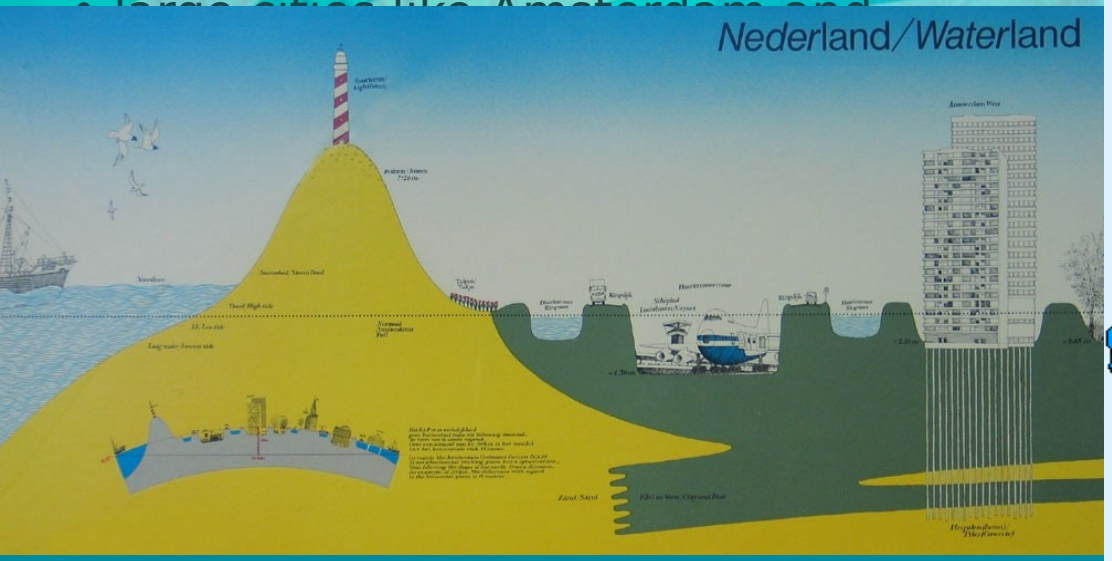
# Part 1: Dutch approach to safety

# Flood protection vital for the Netherlands

**Flood protection is vital for the Netherlands:**

- 60% of our country is threatened by floods
- 70% of our GNP (450 billion €) is threatened by floods
- large cities like Amsterdam and



# Floods 1953 and the Deltaplan

**1953: Catastrophic floods**

- 1836 people died
- 700 square miles flooded

**A new start with the Deltaplan:**

- Closing of estuaries with dams and storm surge barriers (shortening coastline 700 km)
- Safety standards, based on economics
- National dike improvement scheme

# Present safety framework

**Safety is accomplished by:**

- Maintaining the coastline and compensating coastal erosion
- Increasing discharge capacity of the major rivers
- Maintaining flood protection structures
- Providing information (flood warning), conducting research and issuing guidelines

# Authorities involved

**National government/Rijkswaterstaat**

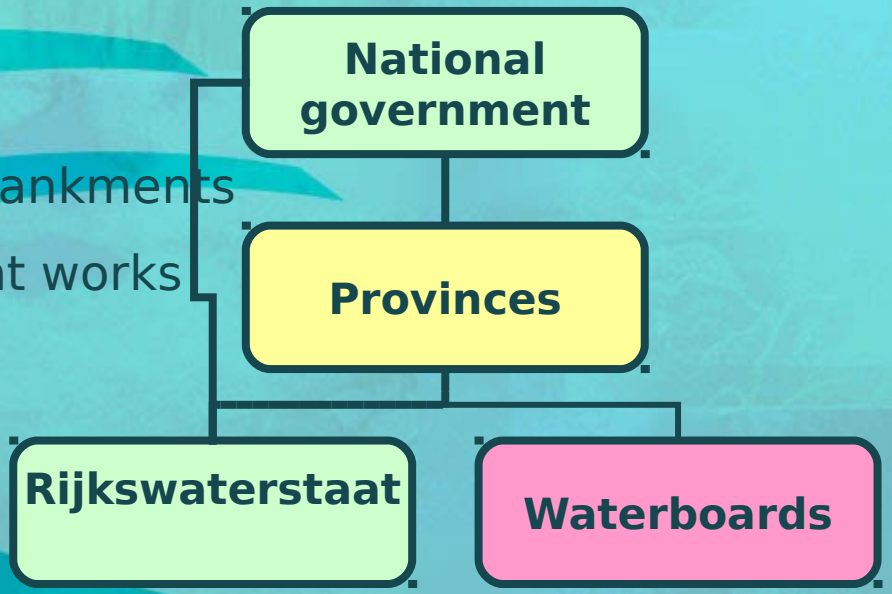
- legislation, safety standards, guidelines and hydraulic boundary conditions (sea level rise, .., ..)
- financing the reinforcement of water defenses
- management and maintenance of coastline, rivers, large lakes and large dams/barriers

**Waterboards:**

- management and maintenance embankments
- safety assessment and reinforcement works

**Provinces:**

- regional supervision
- spatial planning

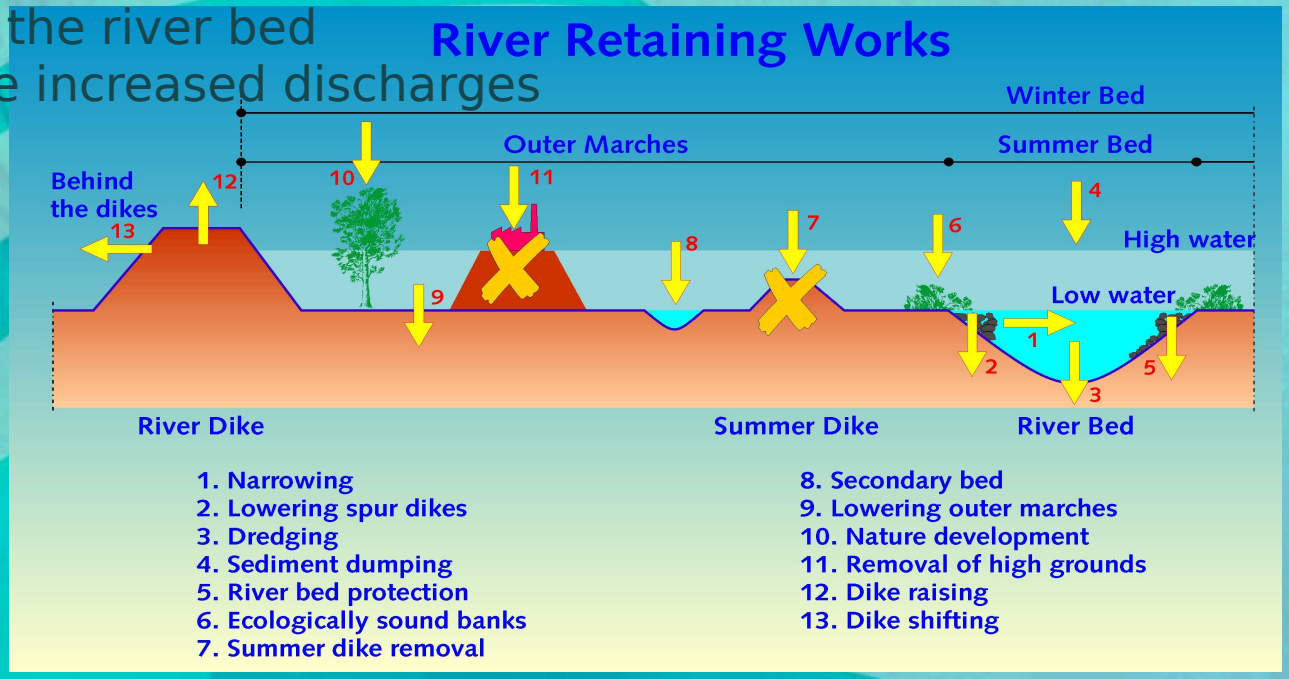


# Coastal management

- Coastal management policy is based on holding the coastline of 1990 and compensating for sand losses in the foreshore
- Rijkswaterstaat carries out a coastal management programme of 16 million yd3 per year (43 million €/year)
- coastal management is based on

# River management

- increasing design discharges would lead to another heightening and reinforcement of river embankments
- widening, deepening and smoothening the river bed accommodate increased discharges
- project costs for the ministry are 2,4 billion €
- future management and maintenance is not yet estimated



# Flood protection system

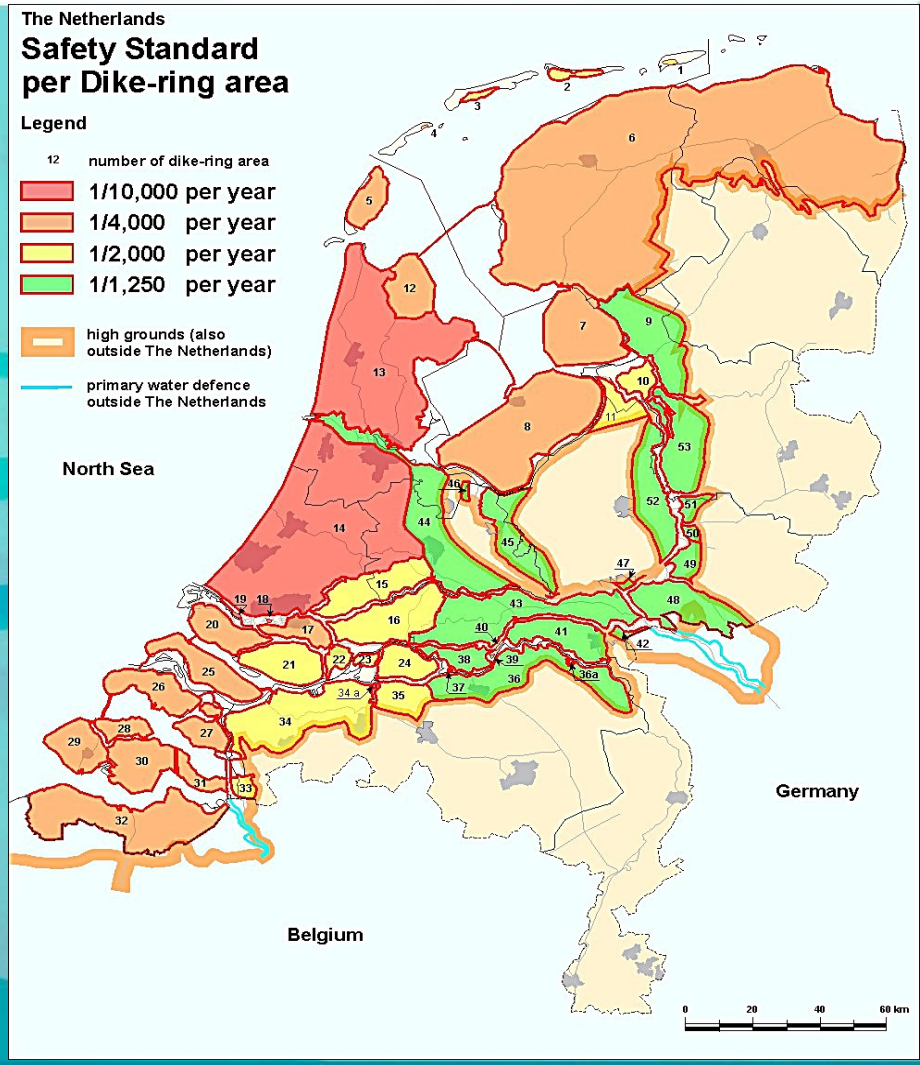
Levees

stem is a closed ring of several structures

# Flood protection act and safety standards

Approximately 2200 miles primary flood protection structures with legally prescribed safety standard, laid down in **Flood protection act (1996):**

- Safety standard per dikering area
- Responsibility of the different parties (water boards, provinces, national government)
- Enforcement of safety assessment every 5 years



# Safety assessment

**Safety assessment:**

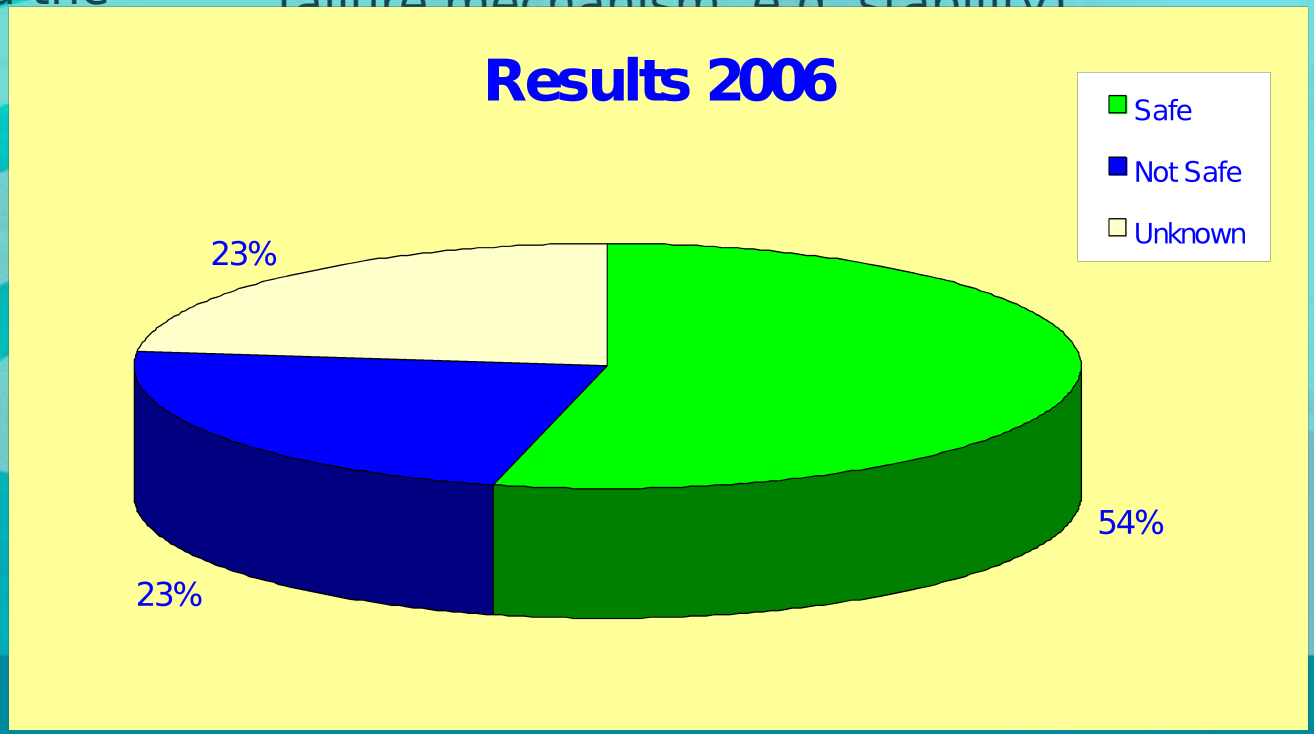
• **C**arried out every 5 years by the local waterboards (since 2001)

•Comparison between strength of a water defense and the (hydraulic) loads

**Provided by the central government**:

• Hydraulic boundary conditions (e.g. wave height and water level)

• And technical criteria (criteria for each failure mechanism, e.g. stability)



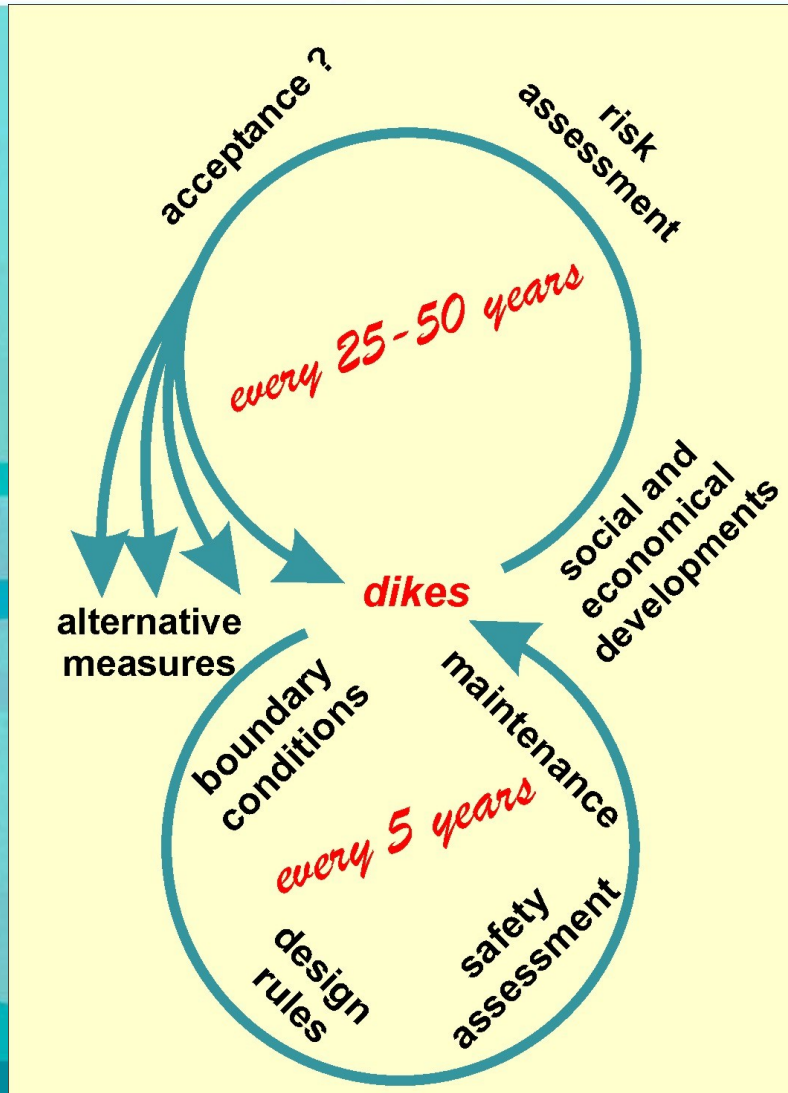
# Different type of measures and costs

When safety standards of the Flood Protections Act are not met reinforcements are carried out (e.g. revetment, but also river management).

- Overall costs of reinforcement works until 2015 about **4.2 billion Euro**
- Maintenance costs (**150 million €/year, local Waterboards, 100 million €/year Rijkswaterstaat**).
- If uncertain further research needed (e.g. soil characteristics)

# Future developments

- The lower circle depicts the present policy of maintaining a fixed safety level and carrying out safety assessment every 5 years.
- The upper circle shows the risk based policy development. The questions is raised whether our current safety standard are still adequate given the mainly societal developments over the past decades.

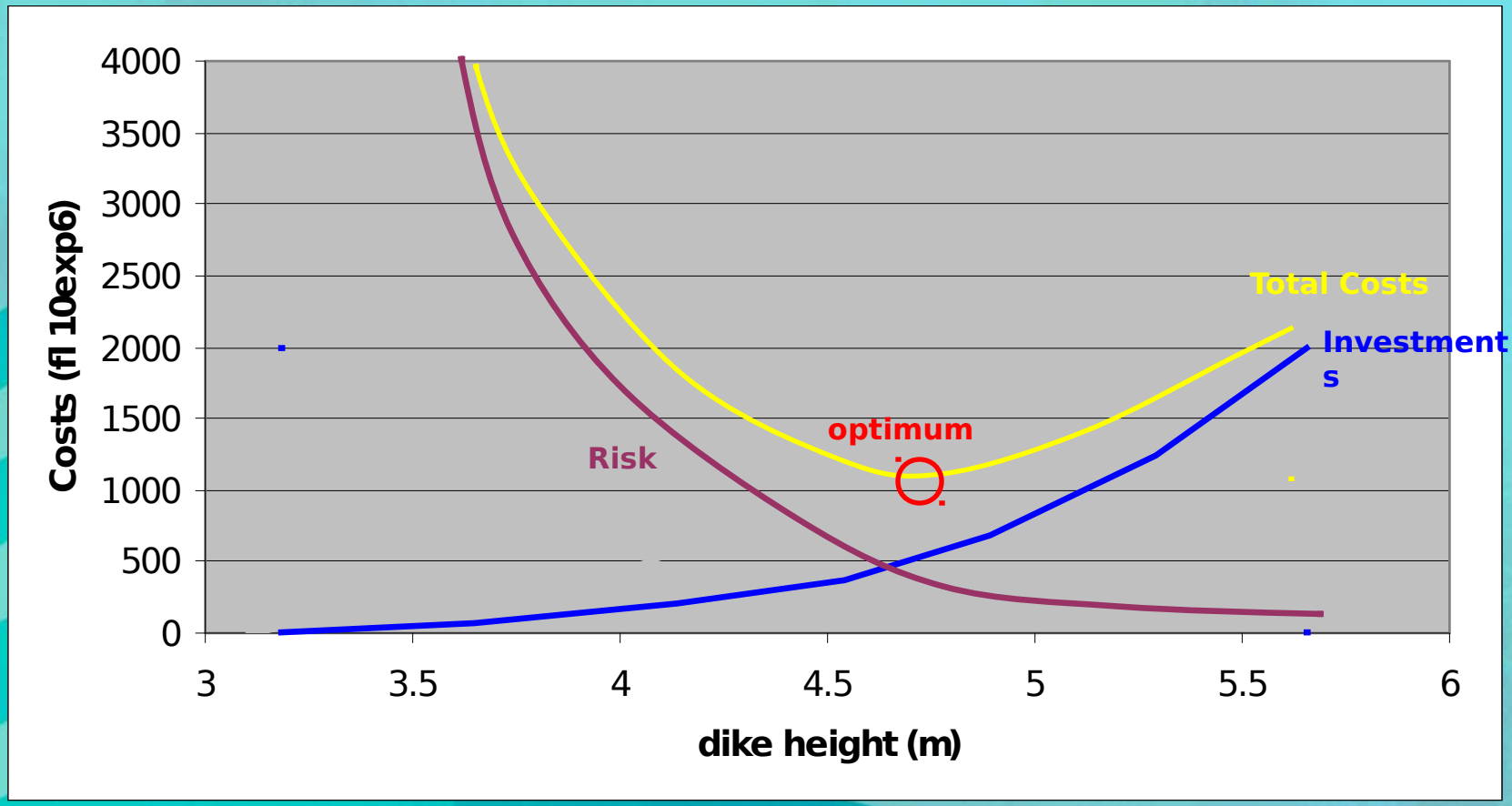


# Towards a risk based approach of flood defence

**Risk = Probability of Flooding X Consequences**

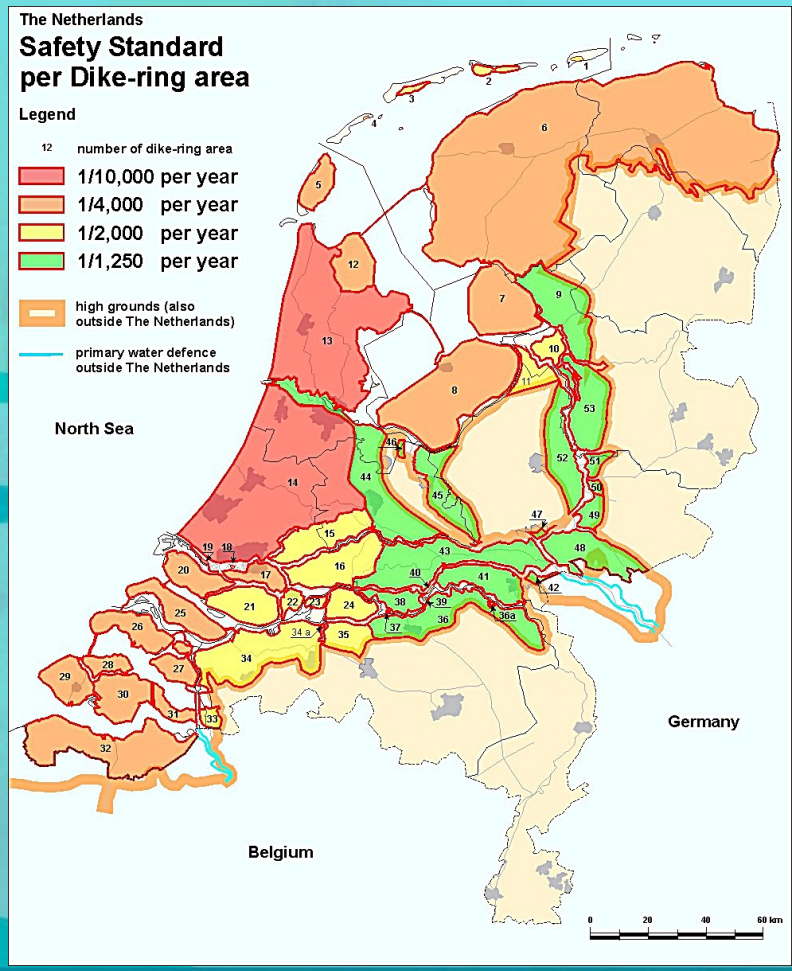
**Why? To achieve a level of protection that is in balance with societal value (Cost Benefit Analysis)**

# Cost benefit analysis: Delta committee (1960)



# Current Standards

- Probability of exceedance of water level limited

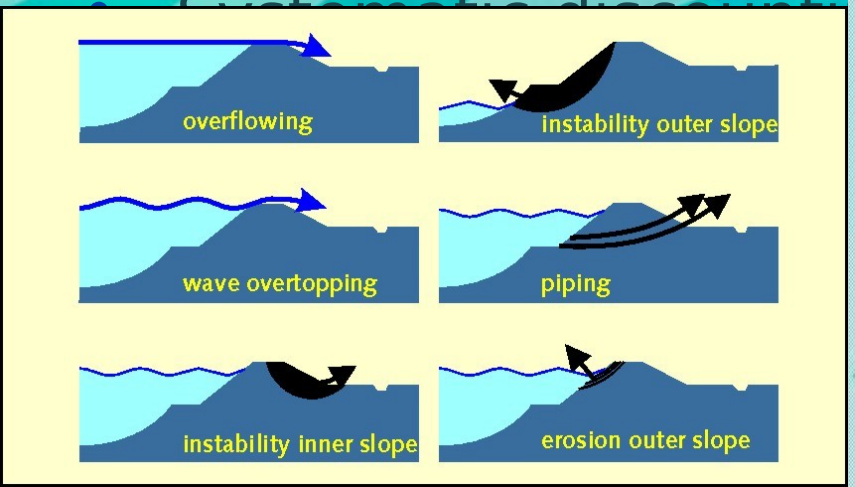


# Probability of exceedance -> Probability of flooding

- Until now: probability of exceedance of design water level
- New concept: actual probability of flooding

Difference:

- Multiple **failure mechanisms**
- From dike section to **dike ring**
- Systematic discussi

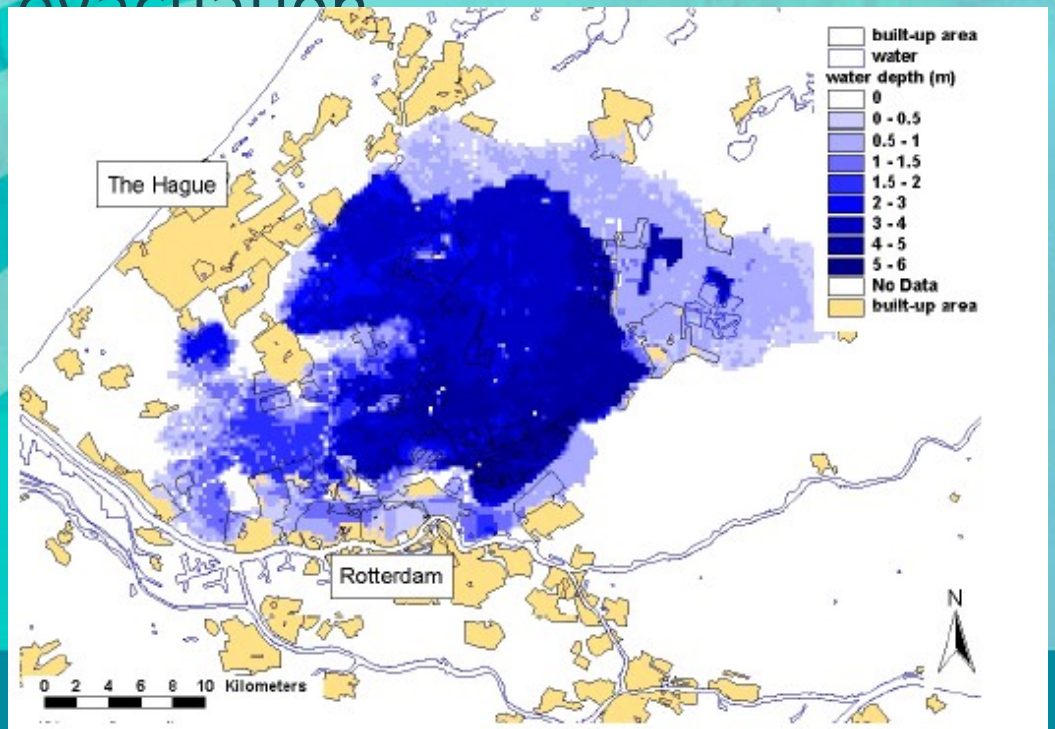


# Consequences

Based on output of flood simulations

Two types of consequences considered:

- Economic damage
- Loss of life and possibilities for evacuation



# Risk based approach

Allows us to:

- Identify weak links in the whole system (dike ring, failure mechanisms)
- To balance level of flood protection and societal values that are protected
- Consider a wide range of measures: dike strenghtening, natural protection, spatial planning, emergency measures

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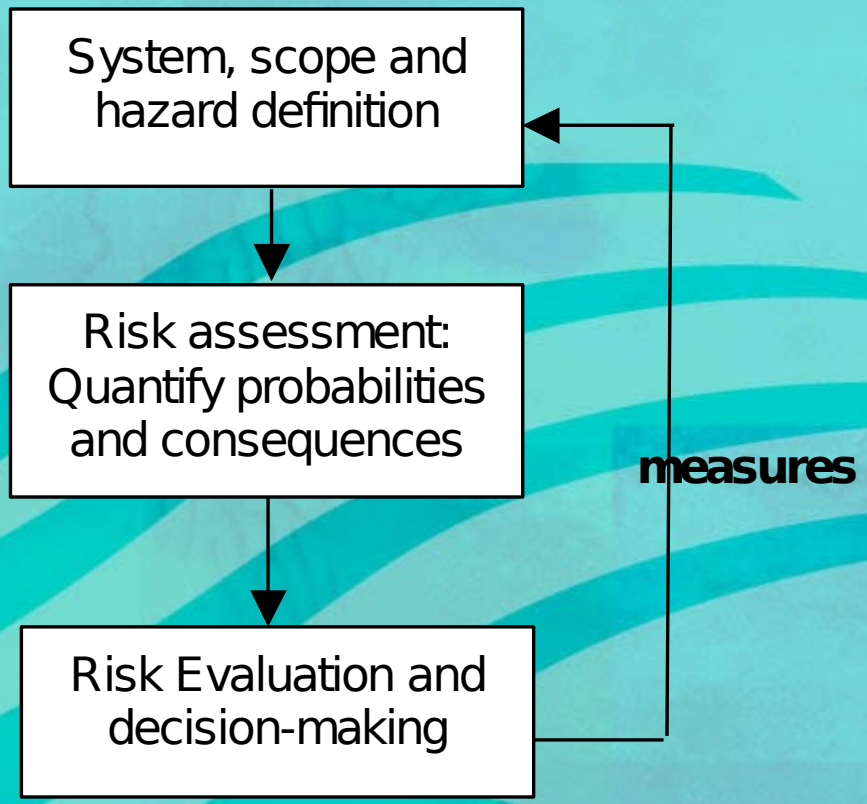
# Part 2: Risk based decision framework: theory

# Risk based decision framework: theory


System, scope and hazard definition
Risk assessment: Quantify probabilities and consequences
Risk Evaluation and decision-making
measures

Area, problem & objectives, risk sources, type of measures

How to approximate flooding probability and consequences, level of detail

Risk evaluation criteria:

- Equity
- Efficiency

Planning and communication

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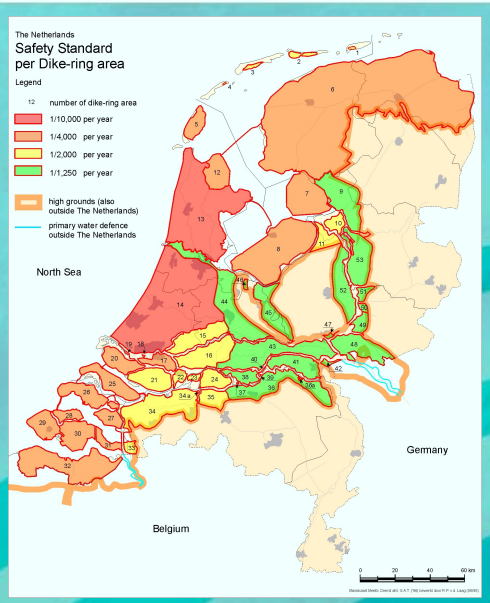
# Part 3: Characteristics of the Dutch appro

# Characteristics of Dutch approach



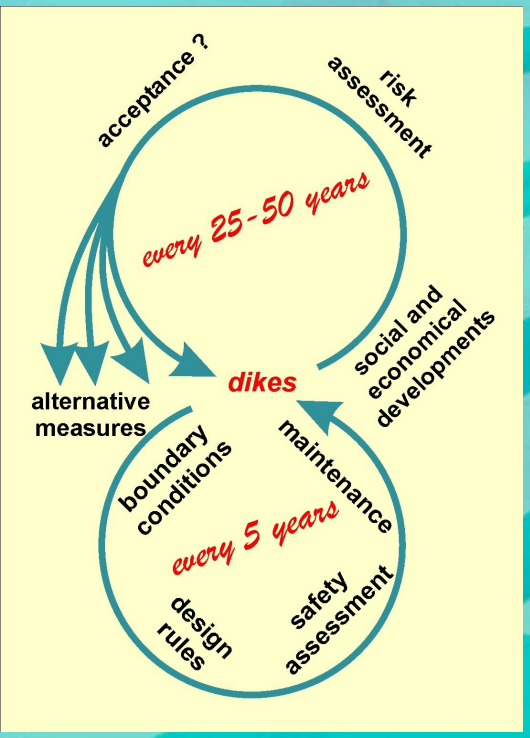

**1. Problem and system definition:**

- Scope / hazards: river, coast, lakes
- Objective: sustainable and long-term safety
- Combination with other functions: navigation, ecology
- Dike ring areas

**2. Risk assessment:**

- Safety standards based on design water level with probability of exceedance
- Future: actual probability of flooding
- Consequences (loss of life, economic damage)

# Characteristics of Dutch approach (2)




**3. Risk evaluation and decision making:**

- Safety assessment
- Procedures for management, maintenance and funding

Future:

- periodic evaluation of the system remains
- More detailled risk assessment
- Other types of measures considered

**Overall:**

(legal) framework guarantees:

- sustainable safety
- funding for measures and maintenance

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# Part 4: Application of the framework to LACPR

# Application of framework to LACPR

Following from LACPR report review and discussions:

**1. Problem and system definition:**

- Area, system and hazards: Louisiana hurricane protection
- Define project goals for safety:
  - Equity, e.g. 1/100 year storm protection
  - Efficiency: better protection of valuable areas such as N.O.
- Define project goals for other functions
- Use protected areas (levee rings) and differentiation of  safety

# Application of framework to LACPR (2)

**1. Problem and system definition (continued):**

- Measures: structural, non-structural, coastal restoration
- Alternatives:
  - 3 to 5 feasible and realistic, but distinctly different alternatives

| Parish | Unprotected | Protected | % Protected |
|---|---|---|---|
| Calcasieu | 420 | 183,151 | 99.8 |

# Application of framework to LACPR (3)

**2. Risk assessment:**

- Safety analysis: based on probability of storms and design water level, e.g. 1/100 year storm
- Consequences: economic damage, loss of life
- Design of system, based on design water level:
  - Systems approach
  - Failure mechanisms
  - Redundancy & Adaptability
- Uncertainties, e.g. sea level rise, subsidience -> Scenario based analysis
- Level of detail of assessment depends on project phase: a first order framework to assess no-regret actions

# Application of framework to LACPR (4)

**3. Risk evaluation and decision making:**

- Evaluate alternatives:
  - Based on predefined criteria and political decision
  - Risk reduction using different indicators (other functions)
  - Cost benefit analysis and optimisation
- Integrate with planning approach
- Develop a system fo
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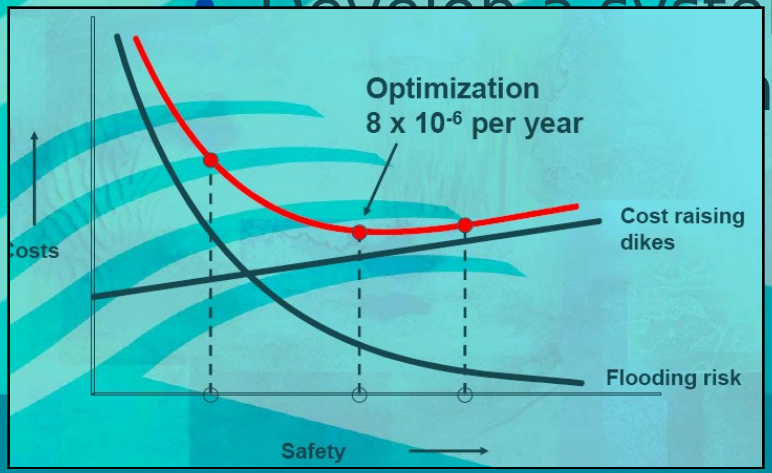


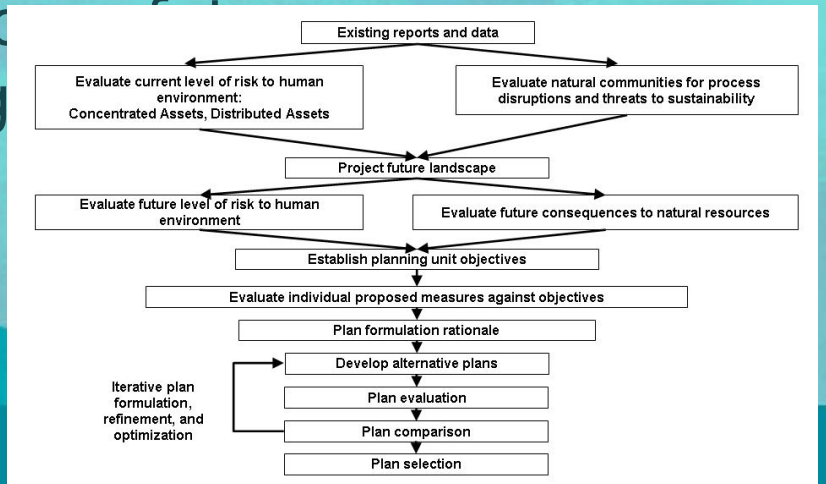
Existing reports and data
Evaluate current level of risk to human environment: Concentrated Assets, Distributed Assets
Evaluate natural communities for process disruptions and threats to sustainability
Project future landscape
Evaluate future level of risk to human environment
Evaluate future consequences to natural resources
Establish planning unit objectives
Evaluate individual proposed measures against objectives
Plan formulation rationale
Develop alternative plans
Plan evaluation
Plan comparison
Plan selection
Iterative plan formulation, refinement, and optimization

**Have a good workshop and thank you for your attention!**